

Our Case No. 11371/125

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
APPLICATION FOR UNITED STATES LETTERS PATENT

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TITLE:

Housing Comprising a Liquid-Tight  
Electric Bushing

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## **HOUSING COMPRISING A LIQUID-TIGHT ELECTRIC BUSHING**

**[0001]** The present patent document is a continuation of PCT Application Serial Number PCT/EP2004/053712, filed December 27, 2004, designating the United States, which is hereby incorporated by reference.

### **BACKGROUND**

#### Field

**[0002]** The present embodiments relate to a housing having a liquid-tight electric bushing.

#### Related Art

**[0003]** In X-ray emitters, an X-ray tube is received in a housing. During the operation of the X-ray tube, coolant oil is circulated through the housing at an overpressure to cool the X-ray tube. Electric lines for triggering and monitoring the X-ray tube are guided through the housing wall by a closure that closes an opening in the housing. Coolant oil flows to the outside of the housing via contact pins that are disposed in the closure and emerges in an unwanted way on the outside of the housing. Conventional closures involve relatively great effort to produce, and thus are expensive. There is a need for a housing with improved tightness and a simplistic design.

### **SUMMARY**

**[0004]** The present embodiments are directed to a housing comprising a liquid-tight electric bushing, which may obviate one or more of the problems due to the limitations and disadvantages of the related art.

**[0005]** A housing having a liquid-tight electric bushing comprises an opening and a printed circuit board. The printed circuit board (pcb) is a closure that

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comprises at least first and second layers. The first layer points toward a housing interior and forms a top side of the printed circuit board, which spans the opening. The printed circuit board prevents the flowing of a liquid received in the housing to the outside of the housing and provides a closure with improved tightness.

**[0006]** , A first contact element is provided on the top side. The first contact element is coupled to at least one electric line received in the housing. The first layer is produced from an electrical insulation material. Thus, the closure is electrically insulated from the housing.

**[0007]** The first contact element is disposed through a blind bore in the first layer and extends to at least the second layer. The bore contributes to preventing liquid received in the housing from flowing transversely through the layers of the printed circuit board.

**[0008]** In another embodiment, the first contact element is connected to a second contact element via a conductor track, which is guided in the interior of the printed circuit board and forms a second layer.

**[0009]** The second contact element is disposed on an underside that is opposite the top side and extends outside an edge of the printed circuit board.

**[0010]** In another embodiment, the printed circuit board is flexible. Thus, simple adaptation is possible, for example, to geometries of the opening that are not planar.

**[0011]** The printed circuit board has a plurality of second layers of conductor tracks disposed one above the other. In this case, the first contact element and the second contact element may be connected via a plurality of conductor tracks, which are disposed one above the other and are electrically coupled to each other. In this embodiment, the housing is liquid tight under extreme loads.

**[0012]** In another embodiment, a seal is provided between the printed circuit board and the housing. Moreover, a pressure plate contacts the underside of the printed circuit board and presses the printed circuit board against the seal, which can

simplify assembly. Because the printed circuit board is mechanically stabilized, the housing is protected against, for example, an overpressure present in the housing.

[0013] The present embodiments are suitable for many types of housings that are filled with a liquid, for example, motor housings and gearboxes, reactors that perform chemical reactions, and the housings of heating and cooling systems. The proposed electric bushing is also suitable an X-ray device. In this case, an X-ray tube is disposed in the housing.

[0014] In accordance with the preferred embodiments, a method of using a printed circuit board as a closure for liquid-tight closing of an opening, which is provided in housing, and as an electric bushing is provided.

[0015] With regard to the advantageous embodiment of the method, the aforementioned characteristics can logically form embodiments of the method.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0016] Further advantages, characteristics and details will become apparent from the ensuing exemplary embodiments and from the drawings. In the drawings:

[0017] Figure 1 is a sectional view of a first exemplary embodiment; and

[0018] Figure 2 is a sectional view of a second exemplary embodiment.

## **DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS**

[0019] In the first exemplary embodiment shown in Figure 1, a housing 1 has an opening 2. A printed circuit board 3 has a first layer 4, made from an electrical insulation material, which points toward the interior of the housing 1 and spans the opening 2. The first layer 4 forms a top side O of the printed circuit board 3. In the interior of the printed circuit board 3, a plurality of electrically conductive second layers 5 are provided in an arrangement one above the other. The second layers 5

are electrically coupled to one another via a bridge 6. For example, the second layers 5 are conductor tracks. An underside U of the printed circuit board 3, which is opposite the top side O, is formed of a third layer 7 that is made from an electrical insulation material. A first blind bore 8 is provided in the first layer 4, and a second blind bore 9 is provided in the third layer 7. A first contact element 10 is mounted on the top side O and connects electrically to the second layer 5 by a first connection 11 that is guided by the first bore 8. A second electrical contact element 12 provided on the underside U is also connected electrically to the second layer 5 by a second connection 13 guided by the second blind bore 9. The first contact element 10 and the second contact element 12 are preferably mounted by SMD (surface mounted device) technology on the printed circuit board 3.

**[0020]** As shown in Figure 1, a pressure plate 14 is mounted on the housing 1 by a screw or screws 15. The pressure plate 14 rests on the underside U of the printed circuit board 3 and presses the topside O against an O-ring seal 16. In this embodiment, the pressure plate 14 spans a substantial portion of the opening 2 and thus stabilizes the printed circuit board 3 against liquid overpressure present in the housing 1.

**[0021]** In the exemplary embodiment shown in Figure 2, the printed circuit board 3 is retained on the housing 1 by a cap 17. In this embodiment, a portion of the printed circuit board 3 protrudes laterally out of the housing 1. The second layer 5 has a bent-over portion 18 on the edge that extends out of the housing 1. In this embodiment, it is possible to produce an electrical connection with the second layer 5 by, for example, snapping a suitable flat plug onto the portion of the printed circuit board 3 that protrudes laterally from the housing 1.

**[0022]** As can be seen from Figures 1 and 2, the opening 2 is spanned by the first layer 4 of the printed circuit board 3. In the first layer 4, a first blind bore 8 is provided that extends at least to the second layer 5. Because the printed circuit

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board 3 has no continuous opening, flowing of coolant oil into a continuous opening of the kind used in the prior art is prevented.

**[0023]** While the invention has been described above by reference to various embodiments, it should be understood that many changes and modifications can be made without departing from the scope of the invention. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, that are intended to define the spirit and scope of this invention.